Waterways Research

Inland Navigation Appointment System Study

Upper Mississippi River Locks 20-25

Center for Transportation Studies

University of Missouri, St. Louis

UMR-IW Navigation System

CTS White Paper for IATP

- Original research sponsored by the Institute for Agriculture and Trade Policy.
- $10,000 partnership effort.
- Final product was a white paper for IATP.

Upper Mississippi River and Illinois Waterways: How to Reduce Waiting Times of Vessels While Using the Current Infrastructure

By

Center for Transportation Studies
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Ronen/Nauss CTS White Paper for IATP

- Presented an overview of the following potential solutions to congestion at the locks in the UMR-IW system:
  - Increase carrying capacity of the locks
  - Reduce the level of demand for the service
  - Reduce the variability of demand
  - Reduce the lock service times
  - Reduce the variability of lock service times

Possibilities for Reduction of Waiting Times

- Increase Capacity of system: build bigger locks.
- Reduce the level or variability of demand: demand management measures.
- Reduce the variability or length of the average service time: operational improvements.

Demand Management Strategies

- Objective of demand management: Lower the peak demand level
- Financial strategies (price mechanisms) :
  - Congestion fees
  - Price the Lockage Service
- Operational strategies:
  - Regular Schedules of Service (buses, trains)
  - Appointment systems (health care, air traffic)

Strategy Comparison

- Pricing mechanisms are controversial and potentially damaging to an already very weak barge transportation industry.
- Operational Strategy advantages:
  - Short time to implementation
  - Minimal financial burden on the barge industry or taxpayers
  - More flexible and customizable

Ronen/Nauss Conclusions

- Revisit the “Small Scale Measures” evaluated by the Corps in 1999.[1]
- Investigate the feasibility of an Appointment System.

[1] U.S. Army Corps of Engineers, ***Upper Mississippi River - Illinois Waterway System Navigation Study: Summary of Small-Scale Measures Screening (Interim Report),*** April 1999, Rock Island, St. Louis, and St. Paul Districts

DOT Volpe Center Report

- Published in September 2003
- Examined in greater detail for the Corps the following alternatives:
  - Excess Lockage Time Fees
  - Tradable Time Permits
  - Long Term Advance Scheduling
  - Appointment System

Volpe Conclusions

- Volpe Center concluded that:
  - Lockage Time Fees are inadvisable due to cost ineffectiveness
  - Tradable Time Permits and Long-term Scheduling are infeasible because of the UMR-IW system's scope and variability
  - A more modest Appointment System shows promise, and should be investigated further

A Complementary Approach . . .

- Both lock expansion and an appointment system will reduce congestion, but these are not necessarily mutually exclusive efforts.
- As the National Academy of Sciences Recommended in their “Review of the U.S. Army Corps of Engineers Upper Mississippi-Illinois Waterway Restructured Feasibility Study: Interim Report”:

Managing Waterway Congestion

"The current system for managing UMR-IWW traffic operates largely on a first-come, first-serve basis. It is possible that new traffic management measures would reduce congestion in a cost-effective manner. Unless an efficient system for managing waterway traffic is in place, it is not possible to evaluate the benefits of lock extensions. Nonstructural measures such as scheduling systems, systems of tradable arrival slots, or a contingent fee--as challenging as their implementation may be--could be implemented instead of extending locks or could be used in combination with lock extensions."

UM-SL CTS Research Proposal to MTC

- Competed for a research grant from the Midwest Transportation Consortium (DOT funds).
- IATP, the Institute for Agriculture and Trade Policy, is the cost sharing NGO co-sponsor.
- Corps supplies data and a model to simulate barge and locking operations over one year time periods on a portion of the UMR-IW system currently subject to significant congestion.

The MTC/IATP/Corps Research

- Focus on measuring the economic benefits and costs of an appointment system.
- Will develop a robust simulation tool to measure the effects of a variety of scheduling strategies.
- Will prepare the groundwork for additional operational testing of an appointment system.

Team for CTS Study

- Research Team is composed of recognized Logistics and Operations Research experts:
  - Ray A. Mundy, Ph.D.
  - Robert Nauss, Ph.D.
  - David Ronen, Ph.D.
  - L. Douglas Smith, Ph.D.
  - Donald C. Sweeney II, Ph.D.

Benefits of the Study

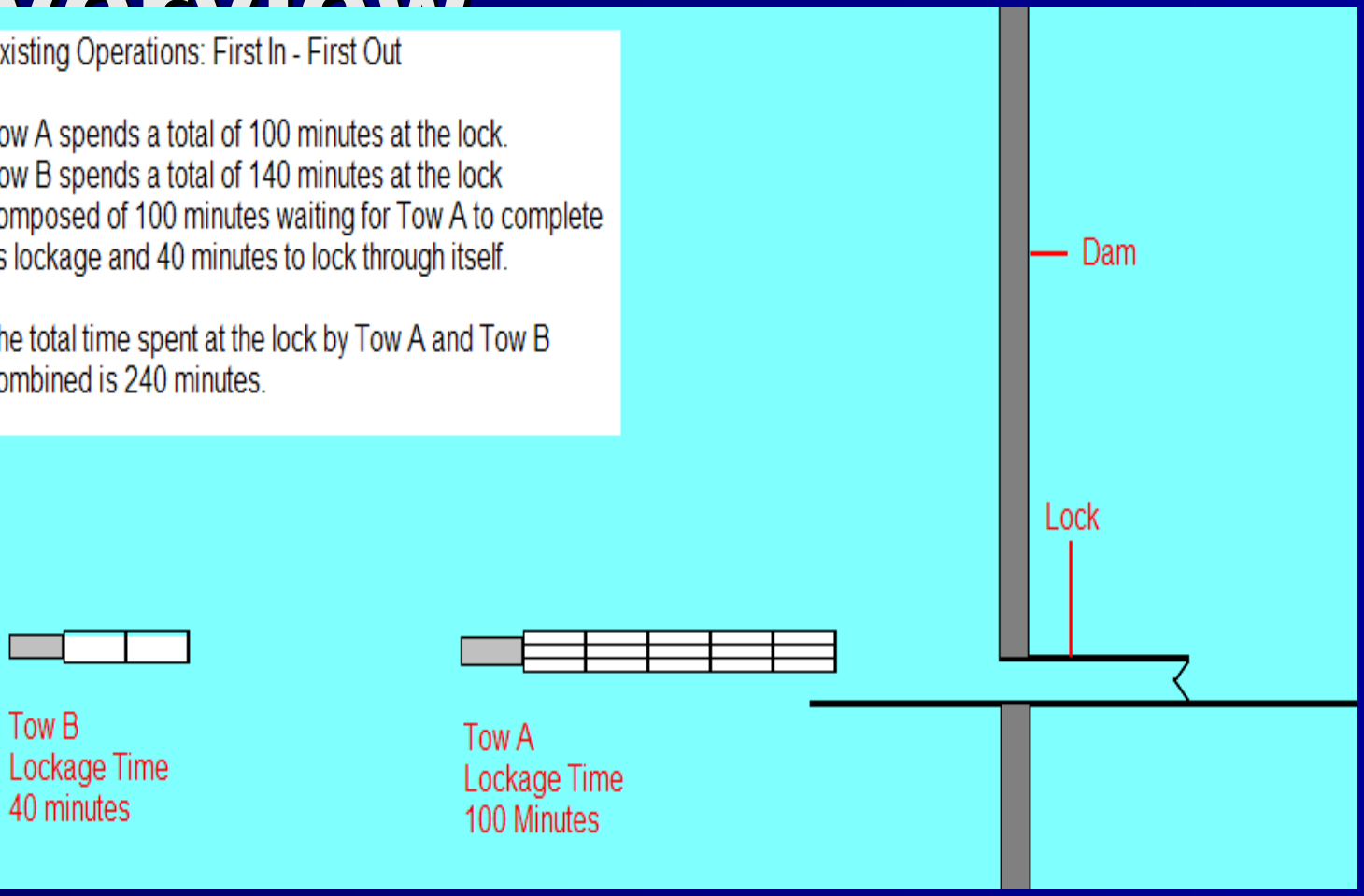
- Develop a framework for the implementation of an appointment system.
- Test and evaluate alternative scheduling rules.
- Provide a sound academic grounding for further work.

Existing Lock Operations Brief Overview

Existing Operations: First In - First Out

Tow A spends a total of 100 minutes at the lock.
Tow B spends a total of 140 minutes at the lock composed of 100 minutes waiting for Tow A to complete its lockage and 40 minutes to lock through itself.

The total time spent at the lock by Tow A and Tow B combined is 240 minutes.



Simple Appointment Scheduling

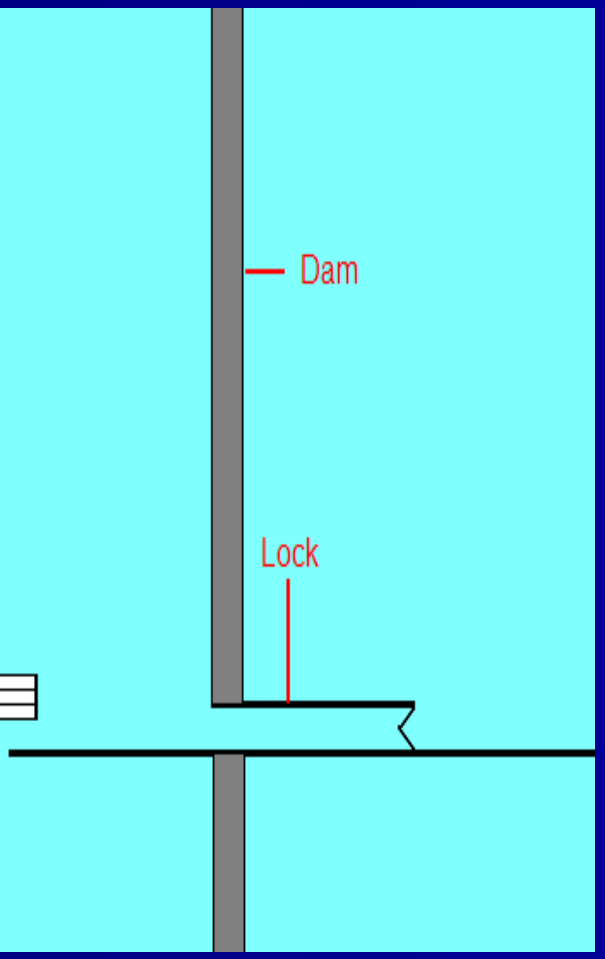
Scheduling First In - First Out:

Tow B is scheduled to arrive when Tow A is expected to complete its lockage. Tow B sails at a speed designed to arrive "just in time" for the completion of Tow A's lockage. Tow B saves fuel enroute to the lock by sailing more slowly and doesn't waste fuel at the lock while waiting for Tow A to complete its lockage.

Note: There is no change in throughput only a decrease in operating costs.

Tow B
Lockage Time
40 minutes

Tow A
Lockage Time
100 Minutes

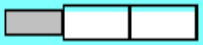


Managed Appointment Scheduling

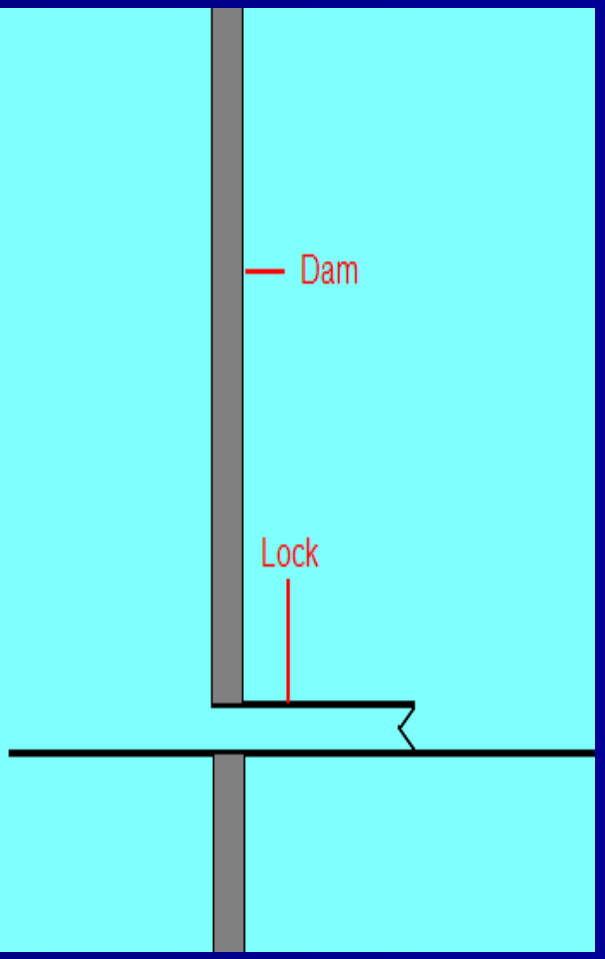
Scheduling with Resequencing:

Tow B is resequenced for processing before Tow A and Tow A is scheduled to arrive "just in time" for the completion of Tow B's lockage. Total system throughput is increased and, in addition, fuel use by Tow A is decreased as it saves fuel enroute to the lock by sailing more slowly and doesn't waste fuel at the lock waiting for Tow B to complete its lockage.

Tow A
Lockage Time
100 Minutes



Tow B
Lockage Time
40 minutes



Benefits of a Successful Appointment System:

- For Shippers and Carriers:
  - More reliable infrastructure resulting from shorter queues at locks and dams.
  - More efficient fuel usage due to less idle time and optimized transit speed between locks.
- Public:
  - Cost-effective solution to congestion problem.
  - Less pollution and environmental damage due to more efficient tow operation.

Project Work Plan Outline

- Initial Study Conference.
- Refinement of Project Scope.
- Development of an Array of Alternative Appointment Systems and Scheduling Rules.
- Data Acquisition and simulation model construction.
- Verification of model.
- Simulation model runs and analyses.
- Conference and Final Report: February-March 2005.

Project Status

- Initial Study Conference Completed.
- Final Study Scope Completed.
- Initial Array of Alternative Appointment Systems and Scheduling Rules for Evaluation Completed.
- Data Acquisition and simulation model construction Completed.
- Verification of Models is nearly complete.

Project Status Details Data Acquisition and Analysis

- UMR-IW Corps of Engineers OMNI data for 2000 – 2002 provided by IWR.
- Data converted from MS Access database to SAS database.
- Data was cleaned and trip and lockage information analyzed in SAS.

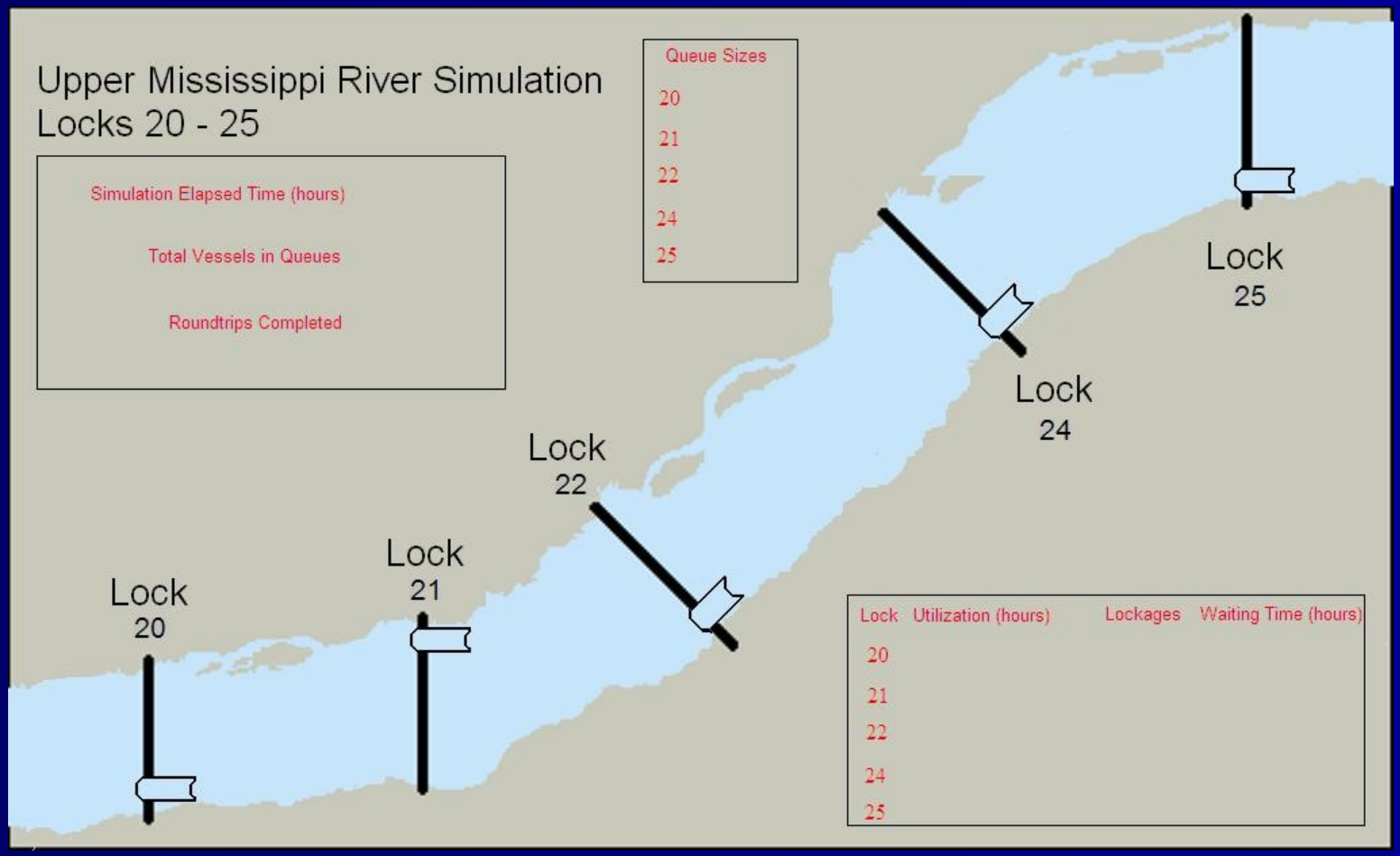
Project Status Details Simulation Models

- MicroSaint 4.1 discrete event simulation software selected for model construction.
- Widely used commercial discrete event simulation software. (Transparent)
- Built-in (but crude) animation tool.
- Graphical user interface.

Project Status Details Simulation Models

- Two models have been built of UMR Locks 20 through 25.
  - Simple model of stylized system with animation. (Sweeney)
  - Complex and detailed model of system without animation. (Study team)
- Closed system models.

Project Status Details Basic Model



Project Status Details Simulation Models

- Three classes of system traffic.
  - Multi-cut commercial tows (systemic).
  - Single cut commercial tows (systemic).
  - Everything else (lock specific).

Project Status Details Simulation Models

- 18 classes of lockages at each lock characterized by:
  - Direction of travel (upbound, downbound)
  - Class of traffic (multi-cut tow, single cut tow, local traffic).
  - Lockage type (fly, turnback, exchange).